SPATIAL PRICE INTEGRATION OF REGIONAL COCOA MARKETS IN INDIA AND WITH WORLD MARKET: A CO- INTEGRATION APPROACH

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Introduction

In contrast to the position of cocoa as a non-conventional crop in India, recently new plantations are appearing especially in southern states *viz.,* Andhra Pradesh, Kerala, Karnataka and Tamil Nadu. The demand for cocoa is increasing due to the rising demand for cocoa as raw material for making confectionaries, beverages, chocolates and health drinks. The improvement in price of cocoa in the market and procurement of cocoa beans by different buyers have made the cultivation of cocoa a profitable venture, which can be attributed to this new shift in the cropping pattern.

Currently, 34000 hectare area is under cocoa cultivation. Andhra Pradesh leads in area under this crop with nearly 14,000 ha followed by Kerala with 10,000 ha and Karnataka with 7250 ha. For the period between 1993-94 to 2008-09 the growth in area under cocoa cultivation in India was 9 per cent, of which Andhra Pradesh is leading in expansion of area under cocoa with an average growth rate of 26 per cent. Production has been grown at 5 percent rate for the period between 1993-94 to 2008-09. The demand for this cash crop is higher than its domestic supply and import the commodity mainly from African countries, to meet the demand. The quantum of import of cocoa beans, cocoa paste, cocoa butter and cocoa powder has been grown at the rate of 17.7 per cent between the period 2004-05 to 2008-09. This huge growth rate in import of cocoa is implying a prosperous future to cocoa growers in India. Cadbury started procurement of cocoa in India. Now more buyers such as Nestle, Amul, CAMPCO etc. are actively participating in the procurement, which makes its price competitive.

Traditionally, the price of cocoa has fluctuated outrageously and has made the commodity difficult to forecast. When it was newly introduced in India and farmers had to neglect this crop few times due to the very low price situation due to excess supply, cheap imports and policies of procuring firms. Thus, the foremost challenge is to attain ways of elude recurrence of past period's very low cocoa prices. With the likelihood of supply exceeding demand, also cheap import from other countries, corrective measures with respect to production, policies associated with procurement for forestalling an imbalance. The present revival of cocoa cultivation scenario in India can be a sustained one, when there is a growing demand for chocolate consumption in the country and also export demand from other countries.

Eventhough cocoa market in India is small and of having less importance in Indian economy, due to the improvement in consumer income, the consumption of cocoa increases through increase in the number of consumers of chocolate and other products. Domestic production of cocoa is about 40 percent of domestic demand and the rest of the demand is met through import. This has to be read with the increase in export demand for cocoa when international firms approaches Indian producers for cocoa due to supply shortage in the international market. As India is a member of WTO since its establishment it is a matter of interest that how international market prices are influencing the domestic price of cocoa. It is thus worthy to gauge the extent to which the world cocoa market is integrated with India's domestic cocoa market.

Although researchers and traders believe that the world market price and domestic price would be close due to the price linkage arises out of the reason that there is no protection given in the domestic market for the commodity due to its small-scale production in the country, it will be beneficial for the researchers

to study the extent of market integration for understanding the market efficiency with which the market performs. Thus, this study attempted to gauge the price co-integration relationship among the regional cocoa markets and with the international market, which can help in understanding the market efficiency to perform its functions is determined with which price changes and responses among the markets are transmitted spatially and temporally.

Price co-integration: Theoretical framework and model specification

Co-integration concept is developed by Granger (1981) and Engle and Granger (1987). Co-integration, is a property of some non-stationary time series and if two or more non stationary time series are co-integrated, a linear combination relationship being stationary is said to exist (Grobys, 2010). Most of the times many of the time series data are non-stationary which may lead to spurious results while analyzing long run relationships. Thus we need to know whether there exists a stationary linear combination of variables of a non-stationary time series data for understanding their long run relationships. The emergence of the unit roots and co-integration literature as pioneered by Granger (1981), Granger and Weiss (1983), Engle and Granger (1987) and Johansen (1988, 1991) has encouraged and enabled applied economists to test for the existence of long-run relationships postulated by economic theory rather than taking them for granted (Dhanya, 2008).

If two markets had tight price relationship, then the two markets would have co-integration. Abundantly study literatures have employed various models to investigate the price co-integration of spatial market (Johansen and Juselius, 1990). Co-integration analysis and error correction models (ECM) have become the widely adopted techniques for studying of price co-integration since their formal development by Engle and Granger (1987).

Suppose that the two time series (Y^t) and (Z^t) satisfy

$$Y_t = aW_t + \varepsilon_t,\ Z_t = W_t + \delta_t, \qquad t \in Z, \qquad \text{(Equation 1)}$$

for some real number $a = 0$, where (W_t) is I(1), and (ε_t), (δ_t) are uncorrelated white noise processes, *i.e.*, $Cov(\varepsilon_t, \delta_S) = 0$, t, s $\in$ Z, and are both uncorrelated to (W_t).

Then (Y_t) and (Z_t) are both I(1), but

$$X_t = Y_t - aZ_t = \varepsilon_t - a\delta_t, \qquad t \in Z, \text{ is I(0).}$$

The combination of two non stationary series yields a stationary process arises from a common component (Wt), which is I (1)

More generally, two I (1) series (Y_t) and (Z_t) are said to be co-integrated (of order 10, if there exist constants μ, $\alpha 1$, $\alpha 2$ with $\alpha 1$, $\alpha 2$ different from 0, such that the process

$$X_t = \mu + \alpha 1 Y_t + \alpha 2 Z_t,\ t \in Z \qquad \text{(Equation 2)}$$

is stationary or I(0).

Without loss of generality, we can choose $\alpha 1 = 1$ in this case. Such co-integrated time series are often encountered in macroeconomics (Granger (1981), Engle and Granger (1987)). The prices of a same commodity in different markets are one example.

The conditions for co-integration between two variables are as follows,

1. Both variables are non-stationary in their levels
2. Both variables show the same integration level
3. A linear combination of these two non-stationary variables possesses a lower integration level (I(d-b)).

Data and Method

Average monthly price series of cocoa were collected from Department of Economics and Statistics (Government of Kerala) for the 6 regional markets of Kerala *viz.,* Alleppy, Idukki, Ernakulam, Pathanamthitta, Kottayam and Thrissur districts. The data was collected for the period between 1998 to 2007. The world cocoa price series were collected on average monthly cocoa prices for the period between 1998 to 2007 collected by the International Coffee Organization (ICO) (source: www. Indexmundi.com).

In this study we have used Engle and Granger approach to test the co-integration between the price series of cocoa in the domestic market and with the international market price. The first step of co-integration analysis is to find whether the price series in the domestic and international markets are integrated of order 1 using the Dicky Fuller unit root test.

Testing for the stability of time series variables

Before examining integration relationships of pair wise vectors, it is essential to test unit root and identify that all variables are integrated at same order, so to discern time-series' stability. Dickey-Fuller (1979) approach (DF) is adopted for testing unit root.

The test assumed the following model for the price series

$$\Delta Y_t = \gamma Y_{t-1} + \varepsilon_t \qquad \text{(Equation 3)}$$

The null hypothesis of the test is $\gamma = 0$

The Dickey-Fuller-test now estimates $a1 = \gamma + 1$ by $\hat{a}_1$, obtained from an ordinary regression and checks for $\gamma = 0$ by computing the test statistic

$$x := n\hat{\gamma} := n\,(\hat{a}_1 - 1), \qquad \text{(Equation 4)}$$

Where n is the number of observations on which the regression is based (usually one less than the number of observations). P-values derived from this distribution can be obtained in SAS by the function PROBDF.

Estimation of the co-integration relation

The second step is estimation of the co-integration relation with OLS regression. Whether two processes (Yt) and (Zt) are co-integrated can be tested by means of a linear regression approach. This is based on the co-integration regression

$$Y_t = \beta_0 + \beta_1 Z_t + \varepsilon_t, \qquad \text{(Equation 5)}$$

where (εt) is a stationary process and $\beta_0, \beta_1 \in R$ are the co integration constants.

One can use the ordinary least squares estimates $\hat{\beta}_0$, $\hat{\beta}_1$ of the target parameters β_0, β_1, which satisfy

$$\sum_{t=1}^{n} (Y_t - \hat{\beta}_0 - \hat{\beta}_1 Z_t)^2 = \min_{\beta_0 \beta_1 \in R} \sum_{t=1}^{n} (Y_t = \beta_0 - \beta_1 Z_t)^2 \qquad \text{(Equation 6)}$$

Testing the residuals for stationarity

Test whether the estimated residuals satisfy

$$\varepsilon = Y - \hat{\beta}_0 - \hat{\beta}_1 Z_t \qquad \text{(Equation7)}$$

The testing of stationarity of residuals can be done by using the Durbin-Watson test.

The procedure AUTOREG (for autoregressive models) used in SAS programme for doing the OLS estimation of coefficients and testing stationarity. When the model includes regressors, the PHILLIPS option in SAS produces the Phillips-Ouliaris co-integration test. The PHILLIPS option computes the Phillips-Ouliaris co-integration test statistic by using the least squares residuals (Phillips and Ouliaris, 1990).

Results and Discussion

The analysis has been carried out using SAS. In the first DATA step the data are prepared for the regression by lagging the corresponding variables. Assuming model in equation 3 the regression is carried out for all series.

In the next step the corresponding test statistics are calculated using equation 4. The regression is carried out with 107 observations the cocoa data contain 108 observations. After that the corresponding p-values are computed. The function PROBDF, which completes this task, expects four arguments. First the test statistic, then the sample size of the regression, then the number of autoregressive variables in equation 3 and a three-letter specification which of the model is to be tested. The first letter states, in which way γ is estimated, here using regression approach and the last two letters state the model ZM (Zero mean) for the model assumed.

In the final step the test statistics and corresponding p-values are given to the output window. Tables 1 and 2 show the results for Dickey Fuller test obtained in the SAS programme.

Table 1. Estimates of coefficients of zero mean model

Obs	xy1	xy2	xy3	xy4	xy5	xy6	xy7
1	-0.17935	.	.	.	.	.	.
2	.	.003572708	.	.	.	.	.
3	.	.	0.031961	.	.	.	.
4	.	.	.	0.22974	.	.	.
5	.	.	.	.	0.083802	.	.
6	.	.	.	.	.	0.18782	.
7	.	.	.	.	.	.	0.021071

Table 2. p values for zero mean model

Obs	py1	py2	py3	py4	py5	py6	py7
1	0.64046	.	.	.	.	.	.
2	.	0.68189	.	.	.	.	.
3	.	.	0.68838	.	.	.	.
4	.	.	.	0.73550	.	.	.
5	.	.	.	.	0.70037	.	.
6	.	.	.	.	.	0.72519	.
7	.	.	.	.	.	.	0.68588

From these results it is found that the p-values do not reject the hypothesis that we have seven I (1) series under the above model at the 5%-level, since they are both larger than 0.05 and thus support that $\delta = 0$. Since we have checked that all price series can be regarded as I(1) we can now check for co-integration.

Phillips-Ouliaris co-integration test

The hypothesis of the Phillips-Ouliaris co-integration test is no co-integration. Unfortunately SAS does not provide the p-value, but only the values of the test statistics denoted by RHO and TAU. Tables of critical values of these test statistics can be found in Phillips and Ouliaris (1990). For the model assumed in this study, which is the so-called standard case, the hypothesis $\gamma = 0$ has been validated for the price series, then used the standard table for the test for critical values of RHO and TAU. The hypothesis is to be rejected if RHO or TAU are below the critical value for the desired type I level error α.

The results showed that both test statistics RHO and TAU are smaller than the critical values for all the pairs of price series (both among the regional markets and with the international market), thus, lead to a rejection of the null hypothesis of no co-integration at the 5%-level. This results shows that there is spatial price integration among the regional cocoa markets in Kerala and also with world cocoa market price.

The output of the AUTOREG procedure contains coefficients of the co-integration regression with their t ratios, Durbin Watson statistic, R Square values and other characteristics of the regression. These results have not been mentioned in this paper because the main objective of the study is to look for the co-integration test statistics for confirming the presence of co-integration between the variables.

Table 3. Results of Phillips- Ouliaris co-integration test

Variable 1	Variable 2	Number of lags	RHO value	Tau value
y1	y2	2	-16.2538	-2.8597
	y3	2	-14.7203	-2.7904
	y4	2	-13.9829	-2.7307
	y5	2	-12.1992	-2.5391
	y6	2	-16.6773	-2.9054
	y7	2	-6.1602	-1.7515
y2	y3	2	-30.3415	-4.0067
	y4	2	-29.3584	-3.9776
	y5	2	-30.3985	-3.9977
	y6	2	-33.0238	-4.3078
	y7	2	-17.5860	-2.9722
y3	y4	2	-23.8787	-3.7158
	y5	2	-35.2937	-4.6377
	y6	2	-24.9962	-3.7115
	y7	2	-16.5390	-2.9819
y4	y5	2	-23.1719	-3.6947
	y6	2	-28.1808	-3.9826
	y7	2	-19.4127	-3.3157
y5	y6	2	-26.0854	-3.7826
	y7	2	-18.1808	-3.1521
y6	y7	2	-11.969	-2.5000

Conclusion

India's cocoa consumption demand is growing and also international chocolate companies are increasingly procuring cocoa from domestic markets. This study seeks to determine the presence of spatial price integration among the regional cocoa markets in Kerala and also its integration with world cocoa market price. From the results obtained it has been confirmed that there is spatial price integration among the regional cocoa markets in Kerala and also with world cocoa market price. This gives an insight in to the mechanism that price fluctuations in the world market will be transmitted to the domestic market and can affect the domestic price since they are integrated.

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